ORIENTATION SENSING IN A MULTI PART DEVICE

The invention relates to a device which comprises a first part having user input means and a three-degrees-of-freedom orientation system and a second part having a display for displaying the orientation of the second part.

US2004/0172838 disclosed a method for measuring a directional of a body in a three-dimensional space defined by an X-axis (magnetic north), a Y-axis, and a Z-axis. The direction of the body is detected with a three-dimensional orientation sensor which comprises a three-dimensional magnetic sensor and a three-dimensional tilt sensor.

Such a three-dimensional orientation sensor is relatively bulky and often cannot be used in a relatively thin display part of a mobile phone which further has a separate part with buttons to receive the user input. When the three-dimensional orientation sensor is located in the part with buttons, the display of the orientation of the display part on the display part may be incorrect.

It is an object of the invention to provide a correct display of the orientation of a part of a device which comprises a one-dimensional or two-dimensional sensor only.

A first aspect of the invention provides a device as claimed in claim **1**. Advantageous embodiments are defined in the dependent claims.

A device in accordance with the first aspect of the invention comprises a first part and a second part which can have another orientation than the first part. The first part has user input means and comprises a three-degrees-of-freedom orientation sensing system for determining a three-degrees-of-freedom orientation of the first part with respect to a reference coordinate frame defined by the earth's gravity field and magnetic field. In the now following the term "n-degrees-of freedom" may also be referred to as "n-dimensional". Thus three-degrees-of freedom means that any orientation in the three-dimensional space can be detected. The second part comprises a display for displaying orientation information on a three-degrees-of-freedom orientation of the second part, and a sensor for sensing an one-degree-of-freedom or a two-degrees-of-freedom orientation of the second part.

The three-degrees-of-freedom orientation of the second part is calculated from the three-degrees-of-freedom orientation of the first part and the one-degree-of-freedom or the two-degrees-of-freedom orientation of the second part. The orientation information is generated in response to the calculated three-degrees-of-freedom orientation of the second part to obtain correct display of the orientation information independent on an orientation of the second part with respect to the first part.

Thus, the three-degrees-of-freedom orientation of the second part is determined by using the offset orientation of the second part with respect to the three-degrees-of-freedom orientation of the first part. This offset orientation is determined by the sensor for the one-degree-of-freedom or a two-degrees-of-freedom orientation of the second part. The position of this one-degree-of-freedom or the two-degrees-of-freedom orientation sensor depends on how the second part moves with respect to the first part. Usually, the first part and the second part rotate with respect to each other around a rotation axis. The complexity of the sensor is determined by the number of degrees of freedom of the movement of the second part with respect to first part.

The present invention may be advantageously used in a two part mobile phone which has the first part with user buttons and a second part with the display.

In an embodiment as claimed in claim **2**, the sensor in the second part comprises an accelerometer or magnetometer sensor. Such a sensor is much smaller than a three-dimensional orientation sensor.

In an embodiment as claimed in claim **3**, the first part and the second part are rotatably connected for rotating with respect to each other in a clamshell movement and/or a swivel movement. For example, for a clamp-shell movement or a swivel movement in one-dimension, a one-degree-of-freedom sensor is sufficient. For a swivel movement in two-dimensions, a two-degree-of-freedom sensor is required.

In an embodiment as claimed in claim **4**, the orientation information comprises an indication of a direction, or text. For a user who is looking towards the screen of the display, the display of, for example, a compass or text is always correctly oriented independent of the orientation of the second part because the three-dimensional position of the second part and thus the display thereof is known. For example, in a clam-shell type movement of the second part towards the first part, without correction, an arrow direction to the north would flip to the south at the instant the second part moves through the direction perpendicular to the earth surface.

In an embodiment as claimed in claim **5**, the open-closed detector detects whether the device is in an open state or in a closed state by using the same three-degrees-of-freedom orientation of the first part and the one-degree-of-freedom or the two-degrees-of-freedom orientation of the second part. Consequently, without any further provisions, it is possible to detect whether the device is closed or open. All conventional actions related to being open or closed can thus be controlled without the need for a further sensor.

In an embodiment as claimed in claim **6**, the three-degrees-of-freedom orientation sensing system comprises an electronic compass. Such an electronic compass may comprise a three-dimensional accelerometer and a three-dimensional magnetometer, or in another embodiment a three-dimensional accelerometer and a two-dimensional magnetometer. Alternatively, the electronic compass may comprise a two-dimensional accelerometer and a three-dimensional magnetometer, or both a two-dimensional accelerometer and magnetometer.

These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiments described hereinafter.

In the drawings:

FIG. **1** schematically shows an embodiment of a two-part device in accordance with the present invention,

FIG. **2** schematically shows another embodiment of a two-part device in accordance with the present invention, and

FIG. **3** shows a block diagram of a circuit for generating the orientation information.

It should be noted that items which have the same reference numbers in different Figures, have the same structural features and the same functions, or are the same signals. Where the function and/or structure of such an item has been explained, there is no necessity for repeated explanation thereof in the detailed description.

FIG. **1** shows a two-part device with a first part **1** which comprises user input means **10** and a three-degrees-of-freedom orientation sensing system **11**, and a second part **2** which comprises the display **20** and the one-degree or two-degrees-of-freedom orientation sensor **21**. The first part **1** and the second part **2** are rotatably connected to rotate with respect to each other around the rotation axis **3** in a clam-shell like movement. Such a two-part device may be a mobile phone, or any other hand-held device with a user input part and a display part which are movable with respect to each other.